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Retired NASA astrophysicist Fred Espenak has witnessed 27 total eclipses from all seven continents, including Antarctica.

COSMIC GAZING

‘Mr. Eclipse,’ an expert on solar eclipses, pinpoints when, where and how to watch America’s first in nearly 40 years

By Matt Alderton

IN THE SAME WAY most people remember their first kiss, Fred Espenak remembers his first total solar eclipse. Although the event was scholarly, not salacious, it was an adventure not unlike other adolescent rites of passage — profound, titillating and completely, instantly addictive.

“It was 1970, and it was the first total eclipse that had passed through the United States since 1963,” recalled Espenak, a self-described “geeky science-nerd kid” who’s now known by the nickname “Mr. Eclipse.” “I was already an amateur astronomer, so I had known about the eclipse for a handful of years. I’d just gotten my driver’s license and managed to convince my parents to let me take the car 600 miles from home in Staten Island, N.Y., to North Carolina so I could be in the path of the eclipse.”

Because he’d read about eclipses, he thought he knew what to expect. Nothing could have prepared him for the real thing, however. “It was the most spectacular thing I had ever seen,” continued Espenak, who now resides in Portal, Ariz. “As soon as it was over I began planning for my next one. That was the start of it.”

By “it” Espenak means his lifelong obsession with eclipses. Like storm chasers who stalk severe weather, he’s spent his life pursuing eclipses — especially total eclipses, which he’s witnessed 27 times from all seven continents, including Antarctica.

“There are two types of eclipses: lunar eclipses, where the moon passes into the Earth’s shadow, and solar eclipses, where the sun is completely blocked by the moon,” explained Espenak, 63, a retired astrophysicist who, in 2009, concluded a 31-year career at NASA’s Goddard Space

Flight Center in Greenbelt, Md. "Total lunar eclipses are quite beautiful to look at, but there's not a lot of science that we can learn from them. Total solar eclipses, on the other hand, we can learn a lot of physics from."

Astronomers often study total solar eclipses because they offer superior views of the sun's outer atmosphere, called the corona, which creates solar wind capable of producing space weather events, aurora effects and even satellite interference.

What interests Espenak most, however, aren't the effects. Rather, it's when and where the eclipses occur. Because he wants to spend as much time as possible basking in their fleeting, ethereal glow, his lifelong hobby has been writing software that predicts the times and places of future eclipses.

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>
> **— Michael Mumma, founding director of the Goddard Center for Astrobiology**

"When I went to college, I had access to big science libraries where I tried to research upcoming eclipses. There weren't a lot of good books published, so I decided to learn how to calculate the physics myself," Espenak said. "I've been writing computer programs for eclipse predictions ever since."

To make his predictions, Espenak uses complex equations that take into account the position of the moon and sun relative to the center of the Earth, and the size and shape of the moon's shadow on the Earth's curved surface. From these, he determines when eclipses will occur, at what time they'll start, how long they'll last and from where on Earth they'll be visible.

"Fred is known for his care and the accuracy of the predictions he makes," said Michael Mumma, founding director of the Goddard Center for Astrobiology and senior scientist in charge of NASA's Solar System Exploration Division.

Espenak's former boss, Mumma gave the go-ahead in 1978 for NASA to publish Espenak's predictions, even though eclipses weren't part of his job description. Since then, NASA has published 13 "eclipse bulletins" co-authored by Espenak and meteorologist Jay Anderson, each containing detailed predictions, maps and meteorology for future eclipses.

"I can't overestimate Fred's importance in developing solar eclipses as true events," Mumma said. "Many people would not be able to experience this marvelous physical event without his guidance and insights."

Espenak also publishes predictions on his personal website (*mreclipse.com*) and in book form. His largest technical publications, the 680-page *Five Millennium Canon of Lunar Eclipses* and the 648-page *Five Millennium Canon of Solar Eclipses* (both available through NASA at *eclipse.gsfc.nasa.gov*) contain descriptions and maps for 5,000 years' worth of eclipses, from 2,000 B.C. to 3,000 A.D.

Although the solar volume alone encompasses 11,898 eclipses, the eclipse du jour is the total solar eclipse that will take place on Aug. 21, 2017. Dubbed "The Great American Eclipse" on its own website (*greatamericaneclipse.com*), it will be the first total solar eclipse visible from the continental United States since 1979. (An eclipse visible from Hawaii in 1991 was partially blocked by cloudy weather.)

"The 2017 eclipse will pass diagonally from the Pacific Northwest down to the Southeast, right through the heart of the country," forecasted Espenak, who said the eclipse will be visible from Oregon, Idaho, Wyoming, Nebraska, Kansas, Missouri, Illinois, Kentucky, Tennessee, Georgia and the Carolinas. "All of North America will get a partial eclipse that day, but the path for the total eclipse is relatively narrow — only about 70 miles wide."

The closer you can get to the middle of the eclipse path the better, according to Espenak, who said the eclipse will last longest — up to 2 minutes and 41 seconds — along the event's "central line," which is the path the axis of the moon's shadow travels on the Earth's surface.

"Personally, I'll be in Casper, Wyo.," he said, noting that he'll drive up to 1,000 miles at a moment's notice if the forecast threatens his view. "There's no way to predict the weather any more than 24 to 48 hours before the eclipse itself, but generally speaking, west of the Mississippi River tends to be sunnier than east, and eastern Oregon probably has some of the most promising weather prospects."

If you miss it, don't fret. "We don't have to wait quite as long for the next total solar eclipse," said Espenak, who noted that the next total solar eclipse will be in 2024, cutting diagonally across the United States in the opposite direction — from Texas to New England.

"I recommend trying to see both 2017 and 2024, because you never know when you will be clouded out, and a total eclipse is something everyone should witness. It's the most spectacular natural phenomenon you can see with the naked eye." ●

STAN HONDA/GETTY IMAGES

Thousands gather in March to watch the moon partially block out the sun as a 100-mile-wide "totality" shadow made its way across the Faroe Islands and Svalbard in Norway.

HOW TO VIEW THE GREAT AMERICAN ECLIPSE

The Great American Eclipse on Aug. 21, 2017, will be the first total solar eclipse viewable from the continental United States in nearly 40 years. Make sure you see it by following astrophysicist and eclipse expert Fred Espenak's four tips:

▸ CHOOSE A LOCATION

Visit eclipsewise.com/solar/SEnews/TSE2017/TSE2017.html to find Espenak's map of the eclipse path. Choose a spot you'd like to visit with your family, preferably near the center of the path, where the eclipse will last longest.

▸ GET GLASSES

Purchase a pair of eclipse glasses — inexpensive cardboard glasses with solar filters, which typically cost only a few dollars. Because you shouldn't look directly at the sun, you'll need these to watch the partial phase of the eclipse. NASA's website recommends purchasing shade number 14 welder's glasses from welding supply outlets. Many online retailers, such as Rainbow Symphony (*rainbowsymphonystore.com*), left, sell inexpensive paper or plastic eclipse glasses.

▸ PACK A JACKET

Temperatures can drop by up to 15 degrees during the totality phase of an eclipse, so dress in layers.

▸ DON'T FORGET YOUR CAMERA OR SMARTPHONE

A smartphone is good enough for most people who want to capture the eclipse in pictures or video. A useful tip from Espenak's site: "Virtually any camera can be used to photograph the phenomenon, but automatic cameras must have their flashes turned off because this would otherwise obliterate the pinhole images." A good smartphone tip is to use a tripod in combination with your smartphone camera's "time-lapse" feature, which allows you to take multiple still pictures of the eclipse during its various phases. You can also purchase an accessory lens for your smartphone (like an olloclip lens) that gives your smartphone a sort of telescopic lens, which is recommended for photographing an eclipse. Some people advise using a solar filter; you can buy one online and place it over your camera to protect the lens from the bright light.

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